# Time Constraints in the School Environment: What Does a Sleepy Student Tell Us?

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ABSTRACT—In this article, we discuss school schedules and their implications in the context of chronobiological contemporary knowledge, arguing for the need to reconsider time planning in the school setting. We present anecdotal observations regarding chronobiological challenges imposed by the school system throughout different ages and discuss the effects of these schedules in terms of sleepiness and its deleterious consequences on learning, memory, and attention. Different settings (including urban vs. rural habitats) influence timing, which also depends on self-selected sleep schedules. Finally, we criticize the traditional view of a necessary strict stability of sleep–wake habits.

## INTRODUCTION

### Anecdotal Observations of Students of Several Ages

*Scene 1*

During a lecture delivered to school authorities in 1992 in the city of Sao Paulo, Brazil, an interesting point was raised when school schedules of public kindergartens were considered. Due to operational reasons, a three-shift schedule was then adopted: 7:00–11:00 hr, 11:00–15:00 hr, and 15:00–19:00 hr; such a system allowed for an increased productivity of the school facilities. Apart from social considerations, a comment was made on the challenge imposed by the second-shift starting at 11:00 hr, which might involve sleep problems in children of preschool age (4–6 years old), The vocal reaction of the audience, strongly denying sleep episodes in the school settings, led us to design and conduct a survey comprising around 2,000 children in a sample of kindergartens in the eastern region of the city. Forms were distributed to teachers in order to register the occurrence of sleep episodes during class activities. As expected, more than a third of the children slept in class, the proportion being larger for the younger children. In spite of the evidence, administrative reasons impeded the necessary change in schedule.

*Scene 2*

By the late 1990s, we received at our lab a visit from the staff of a school receiving children from 0 to 14 years of age, attending activities from 8:00 to 19:00 hr, with an interesting demand: Do children from 4 to 6 years of age need midday naps? The issue was raised by a parent (neurologist mother of a 5-year-old boy) at a school meeting. We answered “yes, of course.” A study was proposed and conducted in the fall and the spring of 1999. On both occasions, sleep episodes at home were recorded by the parents in sleep diaries and in the school by a graduate student who also recorded ongoing classroom and playground activities. In the first stage (fall), the children followed the routine of no napping; in the second stage, a nap window was introduced from 12:45 to 13:30 hr, after lunchtime. In this window, the children who desired to nap were led to a separate, quiet room and the others remained in the classroom engaged in free activities such as drawing and playing with building blocks. Sixty-two percent of the 4-year-old children napped regularly, as well as 40% of the 5-year-old group and 10% of the 6-year-old group. The decision to implement the nap window at this school was then adopted, motivated by a complementary observation of the teachers—both discipline and motivation to perform classroom chores were significantly improved after the nap opportunity.

*Scene 3*

Early morning dialogue between hurried parents and their adolescent son: “We told you not to play computer games till late last night, now look at yourself, sleepy all over… come on,

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you'll be late to school once again." A possible reply: "I switched the computer off at 11, went to bed but could not manage to sleep at all, I guess I finally slept around 2." This scene is played repeatedly with slight variation in tone and content, but the core is unequivocal: there is a tension between body needs for sleep and family timing, apparently unmanageable by stricter rules or logical arguments. Perhaps not even positive reinforcement might work.

These stories illustrate the challenges imposed by school schedules on sleep needs of children, a fact often ignored by education authorities. Sleep habits of older children and adolescents have been studied in several school settings around the world and the outcome is generally the same: school schedules tend to produce sleep deprivation. The reasons for the choice of school schedules by school authorities range from disciplinary to parochial arguments. Another frequently invoked reason for early starting times is that "brains are fresh in the morning, ready to acquire knowledge." In this essay, we will discuss recent findings on this topic, with the obvious expectation that it should be of use to clarify school timing policies.

## Challenges Imposed by School Schedules and Resulting Sleepiness

School schedules, mostly starting hours, often conflict with the sleep needs of students, especially adolescents (Andrade, Benedito-Silva, Domenice, Arnhold, & Menna-Barreto, 1993; Mello, Louzada, & Menna-Barreto, 2001), a fact now understood to derive from imposed hours of wakefulness to sleepy organisms. Human sleep–wake behavior is built from the association of endogenous rhythms dictated by the circadian timing system more or less synchronized by the light–dark cycle and social time cues (Aschoff, 1976; Duffy, Kronauer, & Czeisler, 1996; Mistlberger & Skene, 2004). Synchronization is achieved both by entrainment and by masking and tends to be effective when the endogenous period of the circadian timing system does not differ markedly from the 24-hr environmental cycle (Aschoff, 1965; Roennenberg, Daan, & Merrow, 2003). Besides the obvious discomfort of sleepiness in situations where attention is necessary, attention and memory tend to be impaired (Sadeh, Gruber, & Raviv, 2002), therefore compromising learning performance; mood changes are also frequently reported (Eliasson, King, & Gould, 2002; Fallone, Owens, & Deane, 2002). Weekend sleep–wake pattern changes (delays) are also often shown as consequences of extended sleep deprivation on school days (Binkley, 1993; Carskadon & Davis, 1989; Valdez, Ramirez, & Garcia, 1996). Recovery during weekends is considered insufficient (Hansen, Janssen, Schiff, Zee, & Dubocovich, 2005), thus producing a chronic state of sleep loss and its associated sequels. An important issue has been raised concerning individual differences, where some individuals, notably extreme evening-type (Mercer, Merritt, & Cowell, 1998) students, tend to suffer more from such losses.

## Double Impact of Sleep Deprivation on Learning, Memory, and Attention

Let us consider first the direct effects of sleep deprivation. Several studies have addressed the effects of sleep deprivation on performance of students, mostly focused on memory, attention, and concentration deficits (Dahl, 1996; Randazzo, Muehlbach, Scweitzer, & Walsh, 1998). Simple reaction time and memory test results vary according to time of day, with a general tendency to improve along the day (Colquhoun, 1971). We may speculate that, in this context, brains tend to warm up during the waking hours, a finding conflicting with the assumption of fresh morning brains. A paradoxical finding is the not-well-exploited difference in the circadian pattern differences between short- and long-term memory performances as described by Colquhoun (1971). A generally accepted consensus is that the effects of sleep deprivation tend to increase with chronicity, a situation often found in adolescents who tend to delay their sleep phase (Carskadon, Vieira, & Acebo, 1993), both due to ontogenetic changes (Andrade et al., 1993) and social influences (Carskadon, 2002; Louzada & Menna-Barreto, 2003). A finding to be exploited is the reportedly beneficial effects on mood of acute (single night) sleep deprivation, notably in depressive patients (Selvi, Gulec, Agargum, & Besiroglu, 2007). Impaired attention and concentration may be understood as expressions of interaction with the environment, whereas distraction may represent moments of relative isolation from external stimuli. Therefore, sleepiness associated with distraction (or caused by it) creates a poor learning situation, certainly aggravated by chronicity (Allen, 2003; Andrade & Menna-Barreto, 1996; Sadeh et al., 2002).

Second, but not less important, is the temporal disorder found in chronic desynchronization. Although much of what has been studied about this comes from shift-work studies (Reinberg et al., 1984), there is reason to assume that students are under the same kind of tension as that experienced by adults subjected to irregular work hours. The normally robust circadian variations of body temperature, hormones, and performance tend to show a damped pattern, especially evident when the exposure to irregular schedules is maintained for longer periods. Flattening of rhythms may also reveal disruptions in the sequence of body events which has been nicely depicted as an "Internal Temporal Organization" (Moore-Ede, Schmelzer, Kass, & Herd, 1976; Moore-Ede, Sulzman, & Fuller, 1982), a disruption in which readiness to perform does not coincide with appropriate metabolic or cardiovascular conditions (Moore-Ede et al., 1982). Besides reported pathologic conditions associated with those disruptions, such as insomnia, sleepiness, depression, digestive discomfort, and high blood pressure, one may add similar yet more subtle effects in situations less challenging such as school schedules.

### Contrasting Sleep–Wake Patterns Between School and Nonschool Days

Records of long-term motor activity of adolescents using actimeters (Figure 1), as well as data from sleep diaries, show a typical pattern of change during the week, a pattern that has been called "sleep restriction and extension," with longer sleep episodes during weekends, eventually several hours longer than the sleep episodes during the weekdays (Andrade & Louzada, 2002; Carskadon & Davis, 1989). Weekend sleep extension may be understood as the interaction of both the sleep rebound (not enough sleep on weekdays) and the sleep phase delay, which is frequently found in adolescents. Lack of need for early awakening on weekends certainly helps to build this pattern.

### Self-Selection of Sleep Timing

Electric light has freed humanity from the dependence of daylight, as well as having also opened the opportunity for self-selection of a light–dark cycle. Within limits, this situation is certainly welcome, but negative consequences are also to be expected, such as the disorders associated with irregular working hours (Foster & Wulff, 2005). Most of these disorders are now understood as the outcome of chronically desynchronized organisms. Although much attention in the literature has been devoted to imposed schedules of school or work, few studies have been addressed to self-selected conflicting schedules, such as those frequently observed in adolescents' Internet addiction at night (Johnson, Cohen, Kasen, First, & Brook, 2004). In the context of environmental timing, vacations may be seen as moments of relatively free agendas, thus approximate expressions of body needs for both the duration and the timing of sleep.

Distinct sleep duration preferences have been originally described by Webb (1979) who coined the expressions long and short sleepers—those preferences should be taken into account when we deal with concrete situations where the mean sleep duration of, say, 8 hr tends to be interpreted as normal. Naturalistic observations of sleep habits, contrasting weekdays and weekends, school period, and vacations, will certainly show the amount of sleep a student needs. Another important distinction also arises from such naturalistic observations: the phase preference, characterizing what has become known as larks and owls chronotypes. In the original description by Horne and Östberg (1976), the preference for earlier or later phases of activity coincides with advanced or delayed body temperature circadian variation. Complementary data on sleep duration and phase preferences may be found in controlled studies, with subjects kept in constant conditions showing free-running rhythms (Aschoff, 1998) or submitted to a constant routine protocol such as proposed by Czeisler et al. (1999). In those studies, a relevant finding consists of the dissociation of the circadian sleep–wake cycle from the body temperature cycle, revealing what is interpreted as flexibility of the first rhythm compared to the relative rigidity of the second. The general picture emerging from such studies fits well as a probable explanation for the desynchronization found in shift workers as well as in sleepy adolescents.

### Urban and Rural Settings

Recent studies on differences between urban and rural environments (Louzada & Menna-Barreto, 2003, 2004) must be considered because phase delays tend to be more conspicuous in the urban population, a fact currently explained by the increased social (and illumination) stimuli late in the evening. This seems particularly relevant for adolescents whose natural tendency to eveningness becomes thus reinforced. We have studied the sleep–wake and body temperature circadian patterns of a native population (Torres, 2005; Wey, 2007) in southeast Brazil living without electric energy. Similar circadian patterns were detected for the native adolescents and adults when compared to urban pairs. We also found a rather interesting inversion of the weekend effect, where a phase advance was detected. Our present explanation for the inversion relies on the change of the tribe routine, in which they engage in the commerce of handheld computers and handcraft, concentrated in weekends (because of tourists). Although the Guarani tribe we studied preserves most of their traditional culture, weekends seem to bring them to the interface with another time structure. The model of a sleep restriction–extension pattern described for sleep-deprived adolescents during the week (Binkley, 1993; Carskadon & Davis, 1989; Valdez et al., 1996) is thus seen in a rural, lower technology setting such as found for the Guarani tribe.

### The Necessary Stability?

The concept of occupation of spatial niches by the species is readily understood in the context of evolution. Humans have expanded their niche to all corners of the Earth. The same occupation applies to time, most conspicuously understood in its day–night dimension. Electricity has enabled humans to occupy the night and thus fabricate artificial light–dark cycles, creating flexibility in the exposure to light, which in turn affects the circadian timing mechanisms controlling biological rhythmicity. Considering the above-mentioned flexibility of the human sleep–wake cycle, the implication of self-selected light exposure increased variability in the phase relations between sleep and temperature cycles. Is that relative desynchronization necessarily harmful, as one may ingenuously infer? Everyday evidence does not support that assumption; there is excitement in visiting new temporal niches such as in parties and other incursions into the so-called dead hours of

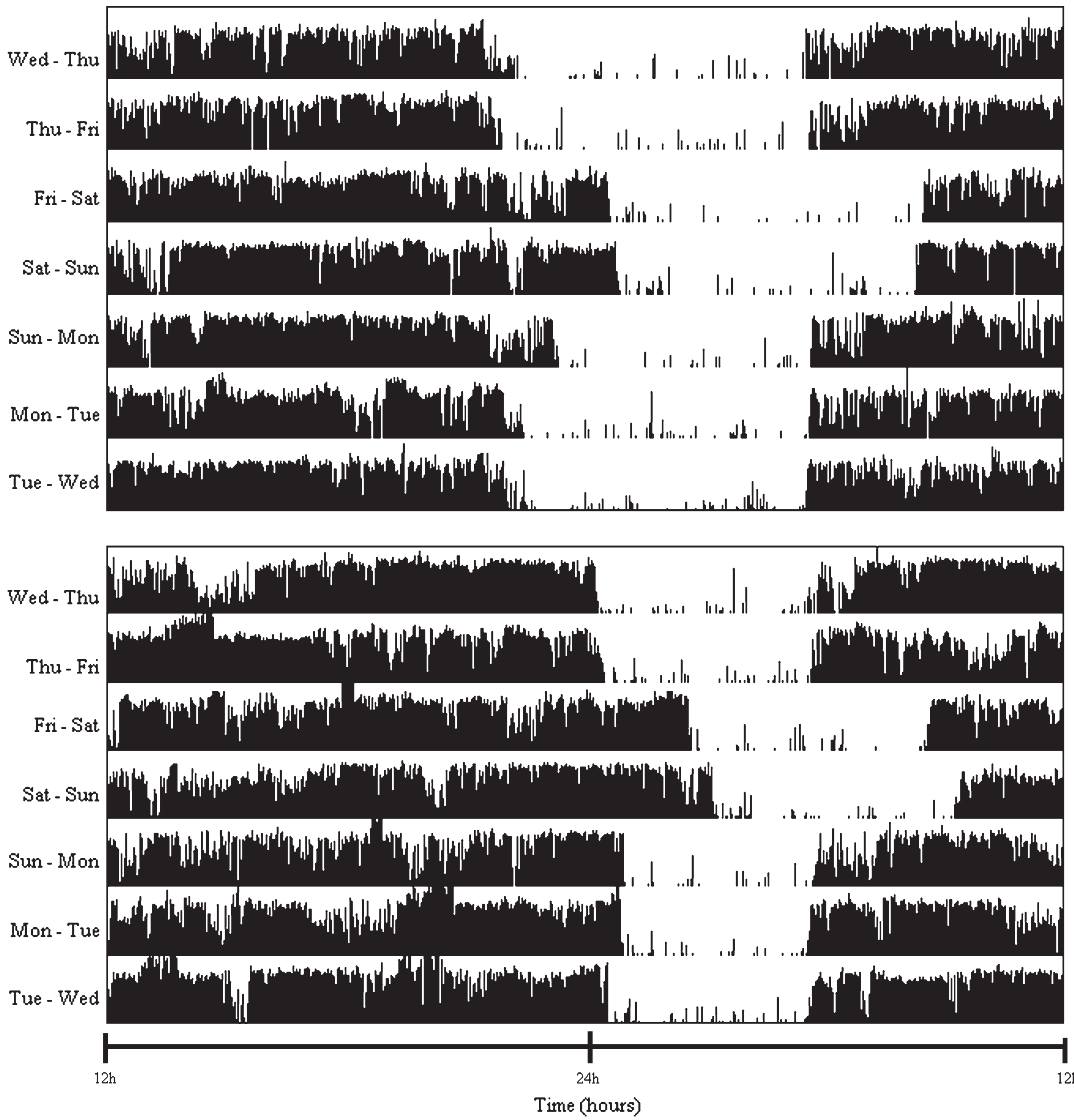


**Fig. 1.** Wrist motor activity actimeter recordings of two adolescents (top graph shows a long sleeper, bottom graph a short sleeper) during a week. *X*-axis: time of day in hours from 12:00 to 12:00. Y-axis: motor activity of nondominant wrist in arbitrary units. Each line represents a 24-hr interval for a day; the 24-hr intervals are designed to show rest nighttime episodes without interruption. Note the phase delay (from Friday to Saturday through Saturday to Sunday) in both cases and the typical restriction–extension pattern as explained in the text.

the night. A change in the time niche may be as rewarding and refreshing as a change in the spatial surroundings longed for during vacations. The problems with time changes arise when the schedule changes are prolonged, imposed, and tend to conflict with our body needs. In a larger time frame, seasonal habits linked to photoperiod and climate changes are also rather obvious adaptations in time both by humans and by nonhumans. Vacations, seen as temporal changes in the context of circannual rhythms, tend to be justified as the need for rest, but the long school summer vacations may be much more than that. Long vacations, as many other time rituals in our societies, stem from traditions adopted a long time ago—summer vacations might have been originally designed to allow time for students to help family harvesting needs (Stark, 2007).

## CONCLUDING REMARKS

Most recommendations for coping with time challenges travel along the road of a supposedly necessary stability, namely, regular sleep–wake habits. In this sense, sleep hygiene rules convey the idea that relatively rigid schedules are associated with a better health condition. This point seems debatable, especially when we try to convince a teenager that late hours are meant for sleep. Traditions in social timing tend to be superficially debated, just like school schedules; some new light seems necessary to clarify those points. Fresher brains in the early morning and refreshed students after summer may be no more than myths, begging to be actualized by contemporary facts and theories on the timing of body and mind functioning.

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